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IMAGES OF FOUR KINDS OF ENGINEERS

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and

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June, 1968 #335-68

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Using a semantic differential and several rank-order questions, two hundred and eighty-four Employed Engineers and Senior Engineering Students reported their perceptions of four engineering sectors: Research Engineers, Design and Development Engineers, Field Service Engineers, and Production Engineers. Engineers in all sectors were perceived as high on conscientiousness and dominance, but a scientific emphasis factor occurred only for Research and Design Engineers, who were also seen as highest in competence and prestige. Practicing Production Engineers agreed with the relatively unfavorable image of their sector. The engineering student's perception of sector prestige is close to that of his faculty but the junior employed engineer's perceptions are close to those of his senior colleagues. Implications of this rapid socialization process for job design and recruitment procedures are discussed.

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IMAGES OF FOUR KINDS OF ENGINEERS

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In industry and government today we are witnessing a continuous and competitive struggle to attract and retain qualified engineers. An important part of this struggle is concerned with attracting engineers into various sectors of the engineering profession, such as Design and Development Engineer, Field Service Engineer, Production Engineer, or Research Engineer. Although this competition between sectors is most evident in the efforts to hire new college graduates, it also exists when engineers change jobs within a company or change companies.

To be successful in the competitive struggle to attract engineers to the various engineering sectors, the hiring agent should be aware of the image of that engineering sector and the factors which form this image. The decision to accept a particular job is influenced not only by such specific job characteristics as local employment conditions and salary but also by the prospective employee's concept of how he, in that engineering sector, would be viewed. If he were a production engineer, would he be viewed differently than if he were a research engineer? Would he be viewed as having more prestige, being more scientific, or being more competent? What are the major influences on these perceptions? What can the hiring agent do to affect potential employees' perceptions of the various engineering sectors?

This study was conducted to determine the images or perceptions of four engineering sectors: Research Engineering, Design and Development Engineering, Production Engineering, and Field Service Engineering. Perceptions of these sectors were obtained from 119 Senior Engineering Students (SES) at a large western state university and 165 Employed Engineers (EE) working for an electronics company in the East. Each respondent completed a questionnaire in which he described an engineering sector on forty-six adjective scales (e.g., scientific-unscientific, ambitious-unambitious, original-unoriginal) and rank-ordered the four sectors on prestige, job satisfaction, and competence. The following questions were investigated:

(1) Are there differences between the images of the four engineering sectors:

(2) What characteristics are associated with the images of each sector?

(3) Do senior engineering students and employed engineers differ in their perceptions?

(4) Are some sectors seen as more favorable than others?

    a. Does this depend on the perceiving group?

(5) How are these perceptions of the four sectors formed?

    a. Are senior engineering students' evaluations of the four sectors more closely associated with those of their parents of their faculty?

    b. Do the perceptions of the employed engineers vary with length of employment?

    c. Do engineers employed in a sector have different perceptions of it than those employed in another sector?

METHOD

A short, three-part anonymous questionnaire was given to the participants in the study. The first part contained a paragraph describing a fictional person, John Smith, who had been working for a major United States corporation in one of the four engineering sectors, and a series of forty-six adjective pairs.[1] After reading about John Smith, respondents were asked to mark a 7-point scale for each word pair to define most adequately the characteristics they associated with John's employment in the given engineering sector. Figure 1 shows the paragraph describing "John Smith, Design Engineer" and the forty-six adjective pairs.

Figure 1. Example of paragraph description and list of the forty-six word-pairs.

John Smith, Design Engineer

John Smith has been employed for the past two year as a design and development engineer for a major U. S. Corporation. As a design and development engineer he participates in the designing of new products by use of the latest engineering techniques and materials. In college John did well scholastically and was well liked and respected by his fellow students. His competence on the job is about average for engineers employed in design work, and his salary is equal to the national average for all design workers. John's future is secure and his prospects for advancement are are equivalent to the advancement of any other design engineer in the corporation.

FORTY SIX WORD-PAIRS USED FOR
ALL FOUR DESCRIPTIVE PARAGRAPHS

John Smith, Field Service Engineer

Active ___:___:___:___:___:___:___ Passive

Aggressive ___:___:___:___:___:___:___ Timid

Altruistic ___:___:___:___:___:___:___ Egotistic

Ambitious ___:___:___:___:___:___:___ Unambitious

Awkward ___:___:___:___:___:___:___ Poised

Clear thinking ___:___:___:___:___:___:___ Muddled thinking

Competitive ___:___:___:___:___:___:___ Cooperative

Confident ___:___:___:___:___:___:___ Lacks confidence

Creative ___:___:___:___:___:___:___ Productive

Daring ___:___:___:___:___:___:___ Cautious

Democratic ___:___:___:___:___:___:___ Autocratic

Dominant ___:___:___:___:___:___:___ Submissive

Easily influenced ___:___:___:___:___:___:___ Mind of own

Efficient ___:___:___:___:___:___:___ Inefficient

Emotional ___:___:___:___:___:___:___ Unemotional

Enthusiastic ___:___:___:___:___:___:___ Unenthusiastic

Essential ___:___:___:___:___:___:___ Non-essential

Feels inferior ___:___:___:___:___:___:___ Feels superior

Flexible ___:___:___:___:___:___:___ Rigid

Follows ___:___:___:___:___:___:___ Leads

Friendly ___:___:___:___:___:___:___ Unfriendly

Hard ___:___:___:___:___:___:___ Soft

Has scruples ___:___:___:___:___:___:___ Unscrupulous

High initiative ___:___:___:___:___:___:___ Low initiative

Humble ___:___:___:___:___:___:___ Proud

Inhibited ___:___:___:___:___:___:___ Uninhibited

Intellectual ___:___:___:___:___:___:___ Non-intellectual

Intuitive ___:___:___:___:___:___:___ Non-intuitive

Low morale ___:___:___:___:___:___:___ High morale

Loyal ___:___:___:___:___:___:___ Disloyal

Masculine ___:___:___:___:___:___:___ Feminine

Mature ___:___:___:___:___:___:___ Immature

Moral ___:___:___:___:___:___:___ Amoral

Objective ___:___:___:___:___:___:___ Subjective

Optimistic ___:___:___:___:___:___:___ Pessimistic

Original ___:___:___:___:___:___:___ Unoriginal

Outgoing ___:___:___:___:___:___:___ Withdrawn

Patient ___:___:___:___:___:___:___ Impatient

Prestige conscious___:___:___:___:___:___:___ Non-prestige conscious

Realistic ___:___:___:___:___:___:___ Idealistic

Respected ___:___:___:___:___:___:___ Not respected

Responsible ___:___:___:___:___:___:___ Irresponsible

Satisfied ___:___:___:___:___:___:___ Dissatisfied

Scientific ___:___:___:___:___:___:___ Unscientific

Sensitive ___:___:___:___:___:___:___ Insensitive

Stable ___:___:___:___:___:___:___ Unstable

In describing the other engineering sectors, identical paragraphs were used except for substituting the name of the appropriate sector and changing the second sentence as follows:

> As a field service engineer he participates in the designing of field installations for the corporation's more complex product lines, and he is responsible for the final checkout and acceptance of completed installations.
>
> As a production engineer he participates in making new engineering designs producible and in the designing

of factory production facilities, acceptance test equipment, and quality control procedures.

As a research engineer he participates in basic and applied research for new product lines.

The curious reader may wish to complete the questionnaire once or twice himself. How would you describe "John Smith, Design Engineer?" How would you describe "John Smith, Production Engineer" in terms of these adjectives?

Although each respondent was asked to describe only one John Smith, the questionnaires were distributed randomly, and there is no reason to assume that there was any systematic bias involved. Had a different group of our respondents described "John Smith, Design Engineer" we have no reason to suspect that our findings would have been appreciably different.

Each respondent completed the second and third parts of the questionnaire. In Part II he rank-ordered the four engineering sectors in terms of:

1. Which engineering field does society consider as being a prestige occupation?
2. Which engineering field do you consider as being a prestige occupation?
3. Which engineering field do you feel provides the greatest personal satisfaction?
4. In which engineering field do you feel the most competent engineers are employed?

The senior engineering students were also asked:

5. Which engineering field does your engineering faculty consider as being a prestige occupation?
6. Which engineering field do your parents consider as being a prestige occupation?

Part III asked for brief background information, including year of graduation, age, and engineering major. Employed Engineers were asked to classify themselves as most closely related to one of the four engineering sectors.

Some characteristics of the respondents. The median age of the employed group was thirty-four, while that of the Senior Engineering tudents was twenty-two and one-half. The Employed Engineers included one-hundred and twenty-one electrical engineers, thirty mechanical engineers, seven aeronautical engineers, three chemical engineers, two civil engineers, and two in other engineering disciplines. The Seniors included forty-three in electrical engineering, thirty-five in mechanical engineering, twenty-six in civil engineering, twelve in chemical engineering, and three in aeronautical engineering. Thus, the sample of Employed Engineers was heavily weighted toward electrical engineering but included a sizable group of mechanical engineers. The Seniors were fairly well distributed among four fields of engineering, but they too include more electrical and mechanical engineers. Of the Employed Engineers one hundred and sixteen were presently employed in Design and Development, thirty-two in Production, fourteen in Research, and three in Field Service.

The number of mployed ngineers describing each engineering sector was as follows: Research Engineer -- thirty-six, Design and Development Engineer -- forty-three, Field Service Engineer -- forty-four, and Production Engineer -- forty-two. The number of Senior Engineering Students describing each sector was twenty-eight, twenty-nine, thirty-one, and thirty-one, respectively.

RESULTS

Question 1: Differences between the sectors

To determine whether the sectors were perceived differently, two kinds of analyses were performed. The first was a factor analysis of the aggregate of forty-six word pairs, and the second, an analysis of variance based on individual word pairs.

Factor analysis.[2] Many of the forty-six word pairs were highly correlated with one another, suggesting that they may reflect common factors which underlie them. To determine whether there were such underlying factors and to identify them, several factor analyses were performed. (Principle component analysis and varimax rotation were used. On the basis of preliminary analyses it was decided to conduct eight factor analyses, one for each of the four sectors as described by each of the two respondent groups. A four-factor analysis was used, since a three-factor analysis provided factors with too many word pairs to be concise and meaningful and the data did not support five factors.)

Four factors underlay the descriptions of the sectors on the adjective pairs. Or, to put it a little differently, the Employed Engineers and Senior Engineering Students really had four basic characteristics in mind when they described the engineering sectors in terms of the forty-six word pairs. These characteristics and adjectives which were a part of them are shown in Figure 2.

Figure 2. Factors Used To Describe Engineering Sectors.

Factor 1. Conscientiousness

Loyal
Moral
Stable
Scrupulous
Satisfied

Factor 2. Dominance

Dominant
Aggressive
Confident
Hard
Leads

Factor 3. *Scientific Emphasis

Scientific
Original
Efficient
Intellectual
Emotional

Factor 4. **Self-Promotion

Prestige conscious
Proud
Egotistic
Cooperative
Feels Superior

*Not present for Field Service or Production Engineers
**Different sectors scored differently on this factor. (See text)

Two factors were used by both groups of respondents in describing all four engineering sectors. We have chosen to call the first of these "Conscientiousness." (In our early informal discussions of the data we jokingly referred to it as the "Boy Scout" factor or the "Batman" Factor.) Adjectives strongly associated with it include loyal, moral, stable, scrupulous, and satisfied.

The second factor used in describing all sectors was "Dominance." Associated strongly with it were words such as dominant, aggressive, confident, hard, and leads.

On the basis of these two factors it is clear that the respondents had two generally favorable characteristics in mind when they described John Smith, regardless of the engineering sector to which he belonged. Apparently both the Employed Engineers and the eniors think of engineers (or at least those of average competence and salary like John Smith) in terms of being conscientious and dominant. Practicing and prospective engineers view other engineers as scrupulous and loyal, dominant and aggressive.

For the third and fourth factors differences were found between sectors. The third factor was called "Scientific Emphasis." Adjectives associated strongly with it included scientific, original, efficient, intellectual, and emotional. This factor was used by both the Employed Engineers and the eniors to describe the Research Engineer and the Design and Development Engineer, but it was completely absent in the descriptions of the Field Service Engineer and the Production Engineer. These results held for both Employed Engineers and Seniors. Apparently "Scientific Emphasis" is seen as relevant to Research and Design Engineering but not to Field Service or Production Engineering.

The fourth factor, "Self-Promotion," was associated with adjectives including prestige-conscious, proud, egotistical, cooperative, and feeling superior. Differences were noted on this factor both between sectors and by respondent group. The Employed Engineers

perceived the Research Engineer in terms of pride and egotism, and the Production Engineer in terms of cooperation, ease of being influenced, and productiveness. Design Engineers and Field Service Engineers were perceived as between these two extremes, more closely associated with the cooperative attitude of the Production Engineer.

On the other hand, the Senior Engineering Students perceived the Research Engineer in terms of withdrawal and cooperation and the Design Engineer in terms of egotism and objectivity. The Field Service Engineer was viewed in terms of superiority feelings and prestige consciousness, while the Production Engineer was described in terms of objectivity and having a mind of his own.

Thus, the Employed and the Student Engineers are in agreement in describing only the Research and the Design Sectors in terms of "Scientific Emphasis." They disagree, however, in that the Employed Engineers describe the Research Engineer more in terms of "Self-Promotion" than the Design Engineer, while the Senior Engineering Students do just the opposite. To understand more fully the images of the four sectors, let us turn to an analysis of the individual word pairs.

Word pair analysis. One-way analyses of variance were performed on the mean scores for each sector on each of the forty-six word pair scales. On three of these scales, both the Employed Engineers and the Senior Engineering Students discriminated between the four sectors so that the results were significant at the .05 level of confidence. These scales were Creative-Productive, Original-Unoriginal, and Scientific-Unscientific. In each instance the Research and Design Engineers were

rated more creative, original, or scientific than the Production or Field Service Engineer. These findings support the results of the factor analysis which showed that the "Scientific Emphasis" Factor applied only to the Design and Research engineers.

The Employed Engineers discriminated significantly between the sectors on an additional seven word pairs, and the Seniors discriminated significantly between sectors on an additional six pairs. The means for each sector on all word pairs for which significant findings occurred are graphed in Figures 3 and 4. (See pages 13 and 14.)

Examination of Figure 3 shows that for the Employed Engineers the Research Engineering Sector consistently has the most extreme scores (eight of ten cases) and the Design and Development Sector has the next-most extreme scores. John Smith in these sectors was rated as relatively more ambitious, competitive, creative, intellectual, pessimistic, original, realistic, and scientific. Production Engineers were often (seven of ten cases) rated at the other end of these scales, that is, as relatively unambitious, emotional, low-initiative, non-intellectual, optimistic, unoriginal, and unscientific. Field Service Engineers were seen as the most cooperative, productive, and unemotional of the four sectors. (Note that we are speaking here in a relative basis. The Production and Field Service Sectors are not seen as unambitious, just as less ambitions than the Research and Design Sectors.)

The Senior Engineering Students (see Figure 4) consistently (seven of nine cases) rate the Field Service Engineer at the extremes of the

Figure 3.

GRAPH OF MEAN SCORES FOR WORD-PAIRS
MARKED SIGNIFICANTLY DIFFERENT
INDUSTRIAL RESPONSES

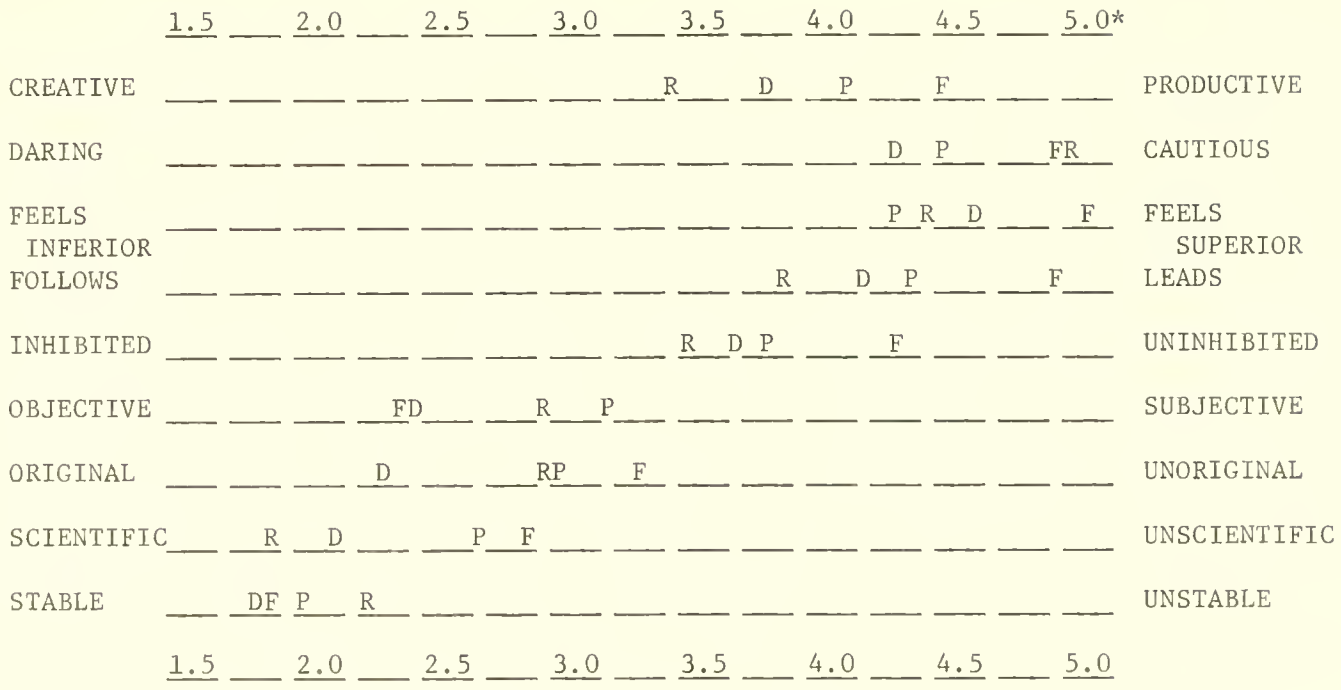
	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0*	
AMBITIOUS			R D		FP				UNAMBITIOUS
COMPETITIVE						R	D	P F	COOPERATIVE
CREATIVE				R	D		P	F	PRODUCTIVE
EMOTIONAL						PD	R	F	UNEMOTIONAL
HIGH INIT.			R	F	D	P			LOW INITIAT.
INTELLECT		R	D	F P					NON-INTEL.
OPTIMISTIC		P	F	R	D				PESSIMISTIC
ORIGINAL			R	D	F P				UNORIGINAL
REALISTIC		F	p	D	R				IDEALISTIC
SCIENTIFIC	R	D	FP						UNSCIENTIFIC
	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	

*Note: Seven point scale expanded between 1.5 and 5.0.

R denotes Research Engineer, D denotes Design and Development Engineer, F denotes Field Service Engineer, and P denotes Production Engineer.

Figure 4.

BAR GRAPH OF MEAN SCORES FOR WORD-PAIRS
MARKED SIGNIFICANTLY DIFFERENT
STUDENT RESPONSES



*Note: Seven point scale expanded between 1.5 and 5.0.

R denotes Research Engineer, D denotes Design and Development Engineer, F denotes Field Service Engineer, and P denotes Production Engineer.

scales on which they discriminate significantly among the sectors. The Field Service Engineers are seen as more productive, feeling superior, leading, uninhibited, objective, unoriginal, and unscientific than the other sectors. The Design and Development Sector is seen as the most daring, original, and stable, while the Research Sector is viewed as the most creative, cautious, following, inhibited, scientific, and unstable. The Production Engineer is seen as least objective and feeling least superior.

This analysis of word pairs supports the results of the factor analyses by showing that "Scientific Emphasis" is an important basis for distinguishing between the sectors. Moreover, the word pair analysis brings to light other differences in the images of the sectors, differences which depend on whether the image is held by the Employed Engineer or the Senior Engineering Student.

Question 2: Characteristics of each sector

On the basis of the analyis which answered Question 1, we have a picture of each sector which emphasizes the differences between sectors. It is also useful to see which adjectives score highest on the average for each sector. The five highest scoring adjectives for the Design and Development Engineer were (highest scoring listed first):

Employed Engineers -- Stable, responsible, respected, friendly, clear thinking

Seniors -- Stable, responsible, respected, mature, friendly

There is a high degree of agreement among all respondents on a favorable image of the Design and Development Engineer.

The highest scoring adjectives for the Field Service Engineer were:

Employed Engineers -- Friendly, masculine, responsible, mature, stable

Seniors -- Responsible, friendly, loyal, stable, respected

Again we see a list of favorable adjectives with a high degree of similarity between respondent groups.

For Production Engineer the highest scoring adjectives were:

Employed Engineers -- Friendly, masculine, stable, responsible, mature, respected (tie between last two)

Seniors -- Stable, friendly, responsible, loyal, mature, respected (tie between last two)

Once again the adjectives are similar between groups and favorable.

Finally, for the Research Engineer, the highest scoring adjectives were:

Employed Engineers -- Scientific, responsible, friendly, clear thinking, stable

Seniors -- Scientific, responsible, clear thinking, respected, friendly

For the Research Engineer there is agreement among respondents, and each group emphasizes "scientific," an adjective not found among the top five for the other sectors. Clear thinking appears among the top five adjectives elsewhere only for the Design and Development Engineer as described by Employed Engineers.

To sum up, the highest scoring adjectives for each sector are favorable and similar for all sectors, with the single exception of "Scientific" being applied to Research Engineers. These findings are consistent with the results of the factor analysis which indicated that

all sectors are seen in terms of being dominant and scrupulous, but Field Service Engineers and Production Engineers are not seen in terms of being scientific or original.

Question 3: Differences between Employed Engineers and Seniors

Both groups of respondents were similar in describing all four sectors in terms of Factor I -- Conscientiousness and Factor II -- Dominance and in describing only the Research and Design and Development Engineers in terms of Factor III -- Scientific Emphasis. On the fourth factor, Self-promotion, differences occurred. The Employed Engineers described the Research Engineer more in terms of this factor, while the Seniors described the Design and Development Engineer more in terms of Self-Promotion. Some differences also occurred in the loadings of some items on particular factors.

Moreover, significant differences occurred between the two groups of respondents on sixteen of the forty-six word pairs in describing at least one engineering sector. The results are summarized in Figure 5. (Page 18.) Employed Engineers rated Design and Development Engineers as significantly more creative, inefficient, unenthusiastic, low-initiative, unoriginal, and impatient than did the Seniors. Employed Engineers rated Field Service Engineers as more unambitious, daring, unemotional, essential, following, and subjective than did the Seniors. Regarding Production Engineers there were only two significant differences. Employed Engineers rated them as more low-initiative and impatient than did Seniors. Finally, seven significant differences occurred in adjectives used to describe Research Engineers. Employed Engineers rated them as more lacking in confidence, creative, daring, essential, rigid,

Figure 5.

WORD-PAIRS MARKED SIGNIFICANTLY DIFFERENT
BY THE EMPLOYED ENGINEERS AND ENGINEERING STUDENTS
(.05 level) "T" Test Analysis

WORD-PAIRS	SES (Means)				IND (Means)			
	DDE	FSE	PE	RE	DDE	FSE	PE	RE
Ambitious-Unambitious	2.52	2.61*	2.90	2.79	2.75	3.29*	3.36	2.64
Confident-Lacks Confidence	2.45	2.51	2.71	3.11*	2.60	2.55	2.64	2.44*
Creative-Productive	3.79*	4.39	4.06	3.36*	3.23*	4.64	4.36	2.83*
Daring-Cautious	4.24	4.87*	4.42	4.93*	4.56	4.30*	4.71	4.00*
Efficient-Inefficient	2.24*	2.29	2.48	2.32	2.86*	2.55	2.69	2.58
Emotional-Unemotional	3.90	3.84*	3.81	4.11	4.09	4.66*	4.07	4.50
Enthusiastic-Unenthusiastic	2.31*	2.77	2.97	2.64	2.95*	2.93	3.26	2.89
Essential-Nonessential	2.69	3.00*	2.68	3.36*	2.98	2.43*	2.81	2.86*
Flexible-Rigid	2.76	3.16	3.16	2.89*	2.95	2.98	3.40	3.44*
Follows-Leads	4.17	4.90*	4.35	3.82	3.84	4.20*	4.21	4.19
High Initiative-Low Initiative	2.52*	2.97	2.84*	2.82	3.21*	3.09	3.71*	2.67
Humble-Proud	4.38	4.45	4.29	3.93*	4.37	4.27	4.52	4.64*
Objective-Subjective	2.41	2.39*	3.13	2.86	2.72	2.91*	2.86	2.44
Original-Unoriginal	2.28*	3.26	2.90	2.86	2.95*	3.18	3.38	2.58
Patient-Impatient	2.21*	2.68	2.39*	2.68	3.09*	2.80	3.19*	2.53
Prestige Conscious-Non-Prestige Conscious	3.38	3.68	3.87	3.79*	3.63	4.05	3.83	3.25*

* denotes those engineering sectors which were significantly different for that word-pair

proud, and prestige-conscious than did the Senior Engineering Students. Although five per cent of these differences are probably due to chance, the rest of them may well reflect a greater personal acquaintance of the Employed Engineers with engineers from the four sectors.

Question 4: Evaluation of the sectors

The participants in the study were asked to rank-order the four engineering sectors on several evaluative questions. Results of these evaluations are shown in Figure 6. (Page 20.) Both the Employed Engineers and the Seniors felt overwhelmingly that society attached greatest prestige to Research Engineering, but both increased the number of first place votes for Design and Development Engineering when asked how they personally ranked the sectors in terms of prestige. The differences in own ranking of prestige between first-place Research Engineering and second-place Design and Development Engineering were 51% for the Employed Engineers and only 4% for the Seniors. When asked which sector employed the most competent engineers, the results were similar. For the Employed Engineers, Research Engineering was first by 23% over Design and Development Engineering, and for the Seniors, Research Engineering was first by 4%. Field Service Engineering and Production Engineering received very few first-place votes in these areas. When respondents ranked the sectors in terms of the personal satisfaction they would derive from each, the results were markedly different. Both Employed Engineers and Seniors said they would gain greatest personal satisfaction from Design and Development Engineering. Research Engineering ranked second for the Employed Engineers and third

PERCENT FIRST CHOICE

	EMPLOYED ENGINEERS				SENIOR ENGINEER STUDENTS					
	SOCIETY PRESTIGE	YOU PRESTIGE	PERSONAL SATISFACTION	COMPETENT ENGINEERS	SOCIETY PRESTIGE	YOU PRESTIGE	PERSONAL SATISFACTION	COMPETENT ENGINEERS	FACULTY PRESTIGE	PARENT PRESTIGE
RE	95.6	75.7	26.5	60.7	73.7	42.0	13.8	45.3	51.4	57.9
DDE	3.2	24.3	62.2	37.5	19.5	38.4	46.1	40.8	42.4	29.3
FSE	0.6	0.0	6.0	0.0	4.3	11.1	30.7	6.1	1.8	6.4
PE	0.6	0.0	5.3	1.8	2.5	8.5	9.4	7.8	4.4	6.4

EVALUATION RANK ORDERINGS OF FOUR ENGINEERING SECTORS

Figure 6.

behind Field Service Engineering for the Seniors. Production Engineering again ranked lowest. Thus, perceptions of personal satisfaction and prestige attached to a sector do not go hand in hand.

Question 5: Formation of perceptions

a. Relation of Senior images to those of parents and faculty.

The last two columns of Figure 6 show the extent to which the Seniors think their parents and faculty would rank each sector first as a prestigious occupation. The student's perception of the prestige his engineering faculty or parents attached to the sectors was between his own personal rating and the prestige ranking he attributed to society. The perceived rating for parents more closely resembled his concept of what society considers a prestigious engineering sector, and the rating attributed to the faculty was closer to his personal evaluation. Perhaps the student's image of engineering sectors moves away from that of his parents and toward that of his faculty as he continues his engineering studies.

b. Perceptions and length of employment. The analyses were done separately for "Junior" Employed Engineers -- thirty-one respondents who were in their twenties and had graduated since 1960. This group should be most similar to the Seniors, since they had had less time to become socialized in their industrial jobs. For all questions, however, this group of junior engineers was almost identical with the average of all the Employed Engineers in their perceptions. Apparently they are socialized very rapidly by their working environment on their first jobs. Moreover, their perceptions of the various sectors formed in

school may have been quite flexible and subject to influence.

c. Perceptions of own sector. Our Employed Engineers included one hundred and four practicing as Design and Development Engineers and twenty-nine working as Production Engineers. Their responses were compared with those of the Employed Engineers Group working in other sectors to determine whether there were any systematic differences in perception of one's own engineering sector. Those employed as Design and Development Engineers were about equal to those from other sectors in the prestige they felt society attached to their sector and in their perceptions of the comptetence of Design and Development Engineers. They themselves attached slightly higher prestige to their own sector, and they attached greater personal satisfaction to working as a Design and Development Engineer.

Those employed as Production Engineers did not see themselves as being employed in a prestigious sector, nor did they feel that Production Egnineers were especially competent. Only 21% of them rated Production Engineering first for personal satisfaction. Consistently the Production Engineers rated themselves well below the Research and Design and Development sectors but more favorably than Field Service Engineers.

To sum up, the process by which images of the engineering sectors are formed appears to be something like this. As students, prospective engineers begin perceiving the various sectors as they think their parents do, but with increasing contact with the faculty, they move toward the images held by faculty. As seniors they are closer to

the faculty in their perceptions than to their parents. These perceptions are relatively unstable and probably based on second-hand information. Very early in their work experience, engineers change their perceptions of the sectors to those held by their senior colleagues. In general, they maintain these new images throughout their professional careers. At all stages of this process, the perception of society's image of the sectors remains fairly constant. Apparently society's image has little influence on changes in perception by the students who become practicing engineers.

It appears that a recruiter faced with this situation should emphasize employed engineers' images of the sectors as he meets with graduating seniors. Because the students' images are subject to change, and because they change early in the professional career toward those of more senior colleagues, emphasis on the perceptions of practicing engineers is most apt to affect the students' attitudes. On the other hand, it will be difficult for the recruiter to influence a practicing engineer to move from a more attractive sector to a less attractive sector. The images held by employed engineers appear to be very consistent throughout their careers.

SUMMARY AND CONCLUSIONS

A questionnaire containing forty-six adjective-pairs and a series of rank-order questions was completed by one hundred and sixty-five Employed Engineers and one hundred and nineteen Senior Engineering Students. Each participant described one of four engineering sectors in terms of the adjectives and ranked the sectors in terms of prestige satisfaction, and competence. The four sectors were: Research Engineering, Design and Development Engineering, Field Service Engineering, and Production Engineering. Analysis of the data through factor analysis and a series of statistical tests showed that clear differences were perceived between the sectors. Major findings were:

1. Engineers in all engineering sectors are perceived as high on conscientiousness -- as scrupulous, moral, loyal, and stable.
2. Engineers in all engineering sectors are perceived as high on dominance-- as dominant, dynamic, aggressive, and confident.
3. Research and Design Engineers are perceived as high in scientific emphasis -- as scientific, original, and competent -- when compared to all engineering sectors.
4. Field Service and Production Engineers are not perceived as being scientific or competent when compared to all engineering sectors.
5. Research and Design Engineering are perceived as the most prestigious sectors.

6. Field Service and Production Engineering are perceived as the least prestigious sectors.
7. Employed engineers feel that Design Engineering is the most satisfying sector of all. They see Design, Production, and Field Service Engineers as low on self-promotion -- as relatively cooperative and humble. They describe the Research Engineer as high on self-promotion -- as egotistical and proud -- but his job is seen as second in satisfaction to Design Engineering.
8. Seniors also feel that Design Engineering is the most satisfying sector of all. In contrast to Employed Engineers, however, they see Design, Production, and Field Service Engineers as relatively high on self-promotion -- as egotistical and proud. They describe the Research Engineer as low on self-promotion -- as withdrawn and cooperative, and they rate his job very low on satisfaction.
9. Practicing Production Engineers concur with the unfavorable image of their own sector, and practicing Design Engineers concur on the favorable image of their sector.
10. Seniors' perception of the prestige of the various sectors is close to their belief about the faculty's perceptions, and junior practicing engineers are much closer in their perception of prestige to senior engineers than to the Senior Engineering Students. Apparently rapid socialization occurs upon employment, and the graduate is easily influenced.

Employers who desire to hire engineers into particular sectors

should be able to improve recruitment and employee retention records by use of the conclusions of this study. The findings indicate ways in which both jobs and recruiting procedures can be redesigned to improve the images of all sectors. For example, the Production Engineer's tarnished image may be improvable by such steps as:

1. Positioning him within the firm, both organizationally and in physical plant location, so as to increase his real and apparent status to a level approaching that of the Design Engineer.
2. Insure that the Production Engineer has scientifically challenging assignments which he can discuss with peer groups from other engineering sectors, so that he will perform publicly in a scientifically competent manner.
3. Design recruitment programs which stress the scientific problems of production engineering, the competence of production engineers, and the satisfaction and prestige which can be derived from work in this sector. Make sure that the recruiters have a favorable and realistic perception of the job openings in production engineering, if this is possible.
4. Assign the newly hired production engineer to a group of more senior colleagues in production engineering who are enthusiastic about their work and the prestige and satisfac-factions which it offers. His attitudes are going to change most during his early experience with the firm, and subsequently they will become more rigid and stable.

To the extent that steps such as these are feasible, the image of an engineering sector can be improved; to the extent that they are not, the sharp differentiation among engineering sectors found in this study will probably remain. Recognition of the ways in which the images of the various engineering sectors are differentiated by employed and prospective engineers and of factors involved in the formation of these images can provide bases for improved recruiting and employment practices for all engineering sectors.

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FOOTNOTES

1. These paragraph descriptions were constructed in final form after a pretest had been given to thirty practicing engineers. For the most part, the questionnaire was satisfactory and required no modification. However, one important change was made. Part I in the pretest described a typical college graduate accepting his initial engineering employment in one of the four engineering sectors. Some pretest respondents had difficulty in marking the word pairs because they were attempting to describe simultaneously their preconceived (and derogatory) concepts of a new engineering hiral and an engineering sector. Therefore, John Smith became a practicing engineer with two years' experience.

2. For details on this analysis see B. W. Hays, "Engineers and Engineering Students' Attitudes on Various Sectors of the Engineering Profession," Sloan Fellow Master's Thesis, Sloan School of Management, M. I. T., June, 1967.

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